RECOVERY PLAN

PYGMY MADTOM
(Noturus stanauli)

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

RECOVERY PLAN

for

Pygmy Madtom (*Noturus stanauli*)

Prepared by

Peggy Shute
Tennessee Valley Authority
Norris, Tennessee

and

Richard Biggins
U.S. Fish and Wildlife Service
Asheville, North Carolina

for

Southeast Region
U.S. Fish and Wildlife Service
Atlanta, Georgia

Approved: _____
Acting Regional Director, U.S. Fish and Wildlife Service

Date: 9/27/94

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1994. Pygmy Madtom Recovery Plan. Atlanta, GA. 20 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
Phone: 301/492-6403 or
1-800/582-3421

The fees for recovery plans vary, depending upon the number of pages.

EXECUTIVE SUMMARY

Current Status: The pygmy madtom is listed as endangered. It presently has a very fragmented, relict distribution, but the species was probably formerly much more widespread within the Tennessee River system. The pygmy madtom is currently known to inhabit only two short stream reaches--the Duck River, Humphreys and Hickman Counties, Tennessee; and the Clinch River, Hancock County, Tennessee.

Habitat Requirements and Limiting Factors: This small catfish inhabits shallow shoals, where the current is moderate to strong and where there is pea-sized gravel or fine sand substrates, in moderately large rivers of the Tennessee River system. The species has been and continues to be impacted by impoundments and is threatened by the general deterioration of water quality from siltation and other pollutants associated with poor land use practices and waste discharges.

Recovery Objective: Downlisting. Because there are only two known populations of the species, it is not likely that it can ever be recovered.

Recovery Criteria: To establish two distinct viable populations.

Actions Needed:

1. Utilize existing legislation/regulations to protect the species.
2. Search for new populations.
3. Monitor existing populations.
4. Develop and utilize an information/education program.
5. Determine the species' life history requirements.
6. Determine threats and alleviate those which threaten the species' existence.
7. Through augmentation or reintroduction, protect and establish two viable populations.

Cost ($000s):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
1995	5.0	10.0	5.0	10.0	25.0	70.0	25.0	150.0
1996	5.0	0.0	0.0	2.5	25.0	70.0	20.0	122.5
1997	5.0	0.0	5.0	2.5	25.0	70.0	20.0	127.5
1998	5.0	0.0	0.0	2.5	0.0	30.0	10.0	47.5
1999	5.0	0.0	5.0	2.5	0.0	20.0	5.0	37.5*
2000	5.0	0.0	0.0	2.5	0.0	10.0	5.0	22.5*
2001	5.0	0.0	5.0	2.5	0.0	10.0	5.0	27.5*
2002	5.0	0.0	0.0	2.5	0.0	10.0	5.0	22.5*
2003	5.0	0.0	5.0	2.5	0.0	10.0	5.0	27.5*
2004	5.0	0.0	0.0	2.5	0.0	5.0	5.0	17.5*
2005	5.0	0.0	5.0	2.5	0.0	5.0	5.0	22.5*
Total	55.0	10.0	30.0	35.0	75.0	310.0*	110.0	625.0*

*Some habitat improvement costs needed for the species' reclassification will not be known until the magnitude of specific threats is determined through research. Therefore, costs for habitat restoration may be considerably more expensive.

Date of Recovery: Recovery of the pygmy madtom is not likely.

TABLE OF CONTENTS

INTRODUCTION

The pygmy madtom (*Noturus stanauli*), a Tennessee River drainage endemic, was listed as an endangered species on April 27, 1993 (U.S. Fish and Wildlife Service [Service] 1993). This species is known from one population in each of two rivers in the Tennessee River drainage that are separated by about 600 river miles (the Duck River, Humphreys and Hickman Counties, Tennessee; and the Clinch River, Hancock County, Tennessee). There are no other historic records for the species within the Tennessee River drainage. However, madtoms have very secretive habits and consequently are difficult to capture. Although both rivers have been extensively surveyed, the pygmy madtom has been taken in only very specific, localized habitats in both of the known localities. Even at these sites, however, the species is not consistently taken. In fact, to date, fewer than 50 total individuals of this species have been collected. Although specific details have not been resolved with regard to the species' range within the Tennessee River system, it is appropriate to assume that the species was likely once more widespread in the Tennessee River system and went undetected at other localities.

Description, Ecology, and Life History

The pygmy madtom (*Noturus stanauli*) was described by Etnier and Jenkins (1980). This small, slender catfish is the smallest of the known madtoms (maximum length 1.5 inches) (Etnier and Jenkins 1980). Its head is flat and is a dark brownish gray, except for the unpigmented areas around the tip of the snout and nares. It has a very distinctive pigmentation pattern--dark brown or black above the midline of the body and pale yellow or white below. Also, most or all of its fins are unpigmented. It has eight soft pectoral fin rays and 14 to 16 anal rays. The pectoral spines have strong recurred posterior serrae and well-developed anterior serrae (see Etnier and Jenkins 1980 and Starnes and Etnier 1980 for more complete descriptive information).

Much of the species' life history is unknown. However, much can be inferred from comparisons with closely related species. According to most recent phylogenies, the pygmy madtom's closet relatives are members of a group including the least madtom (*N. hildebrandi*) and the smoky madtom (*N. baileyi*) (Grady and LeGrand 1992).

The known populations of pygmy madtom occur in moderate to large rivers. They have been collected from shallow shoals where the current is moderate to strong and there is pea-sized gravel or fine sand substrates. Although there are no observations of seasonal habitat shifts, the closely related smoky madtom is known to switch from riffles to overwinter in shallow pools (Dinkins 1984). Many individuals are also found in the flowing portions of pools during the reproductive season (Dinkins and Shute 1993).

Etnier and Jenkins (1980) noted that only two age groups were evident in collections of the species, indicating a life span of 1+ years. The average life span of most madtoms is 2 or 3 years. However, members of the subgenus Rabida, of which *N. stanauli* is a member, are the shortest-lived madtoms.

Pygmy madtom reproductive behavior is probably similar to that of closely related madtom species. Related madtoms nest in cavities beneath slabrocks and at times use other cover objects, such as cans and bottles. As native mussels are abundant in pygmy madtom habitat, it is possible that this species might use empty mussel shells for nesting cover. Reproduction likely occurs from spring to early summer; smoky madtom and least madtom reproduction occurs between late May and mid-July (Dinkins 1984, Mayden and Walsh 1984). Males guard eggs and young within their territories for several weeks, until the young are actively feeding. Other riffle-dwelling madtom species have been observed nesting in the shallow heads or foots of pools (Starnes and Starnes 1985), including the closely related smoky madtom (Dinkins and Shute 1993) and least madtom (Mayden and Walsh 1984).

Madtoms almost exclusively prey on aquatic insect larvae. Most authors have suggested that they are primarily opportunistic feeders and take prey items in proportion to their abundance (Starnes and Starnes 1985, Gutowski and Stauffer 1990).

Distribution, Reasons for Decline, and Threats to Its Continued Existence

The fish fauna of the Tennessee River valley has been extensively surveyed (O'Bara 1991; Etnier and Starnes, in press); however, the pygmy madtom, which was likely once more widespread in the Tennessee River system, has been collected from only two short river reaches separated by about 600 river miles (Etnier and Jenkins 1980, O'Bara 1991). It has been taken from the Duck River, Humphreys and Hickman Counties, Tennessee; and from the Clinch River, Hancock County, Tennessee.

Based on the results of recent surveys (O'Bara 1991), the pygmy madtom still exists in the Clinch River. Five specimens were taken at one of the two known historic sites in the Clinch River in the fall of 1990 (O'Bara 1991), and two specimens were taken at the type locality by W. C. Starnes and R. T. Bryant (specimens at the University of Tennessee, Knoxville, Tennessee) in the fall of 1991.

O'Bara (1991) was not able to find the species in the Duck River during his surveys, and Etnier (University of Tennessee, personal communication, 1993) reported that his collections of the historic collection site in the mid-1980s were unsuccessful. At the time the pygmy madtom was listed, it had not been taken from the Duck River since 1974 and was feared extinct. However, in November 1993, three pygmy madtoms (one young-of-the-year) were taken in the Duck River,

Hickman County (Saylor, Tennessee Valley Authority, in litt., 1993). Etnier and Jenkins (1980), in their description of this species, reported that it had been taken in only about one-half of the collections made at the Clinch River sites and only about one-fourth of the collections at the Duck River site.

The pygmy madtom, which coexists with other federally listed species in the Clinch River, is threatened by the general deterioration of water quality from siltation and other pollutants associated with poor land use practices and waste discharges. Benthic habitats in the section of the Duck River where the species has historically been taken are being seriously threatened by stream-bank erosion. The aquatic resources of the Clinch River are potentially threatened by increased urbanization, coal mining, and poorly managed agricultural practices. Because the pygmy madtom may exist in only one short river reach, this population could easily be lost to a single toxic chemical spill.

Because the two known populations are isolated from each other by impoundments, recolonization of any extirpated population would not be possible without human intervention. The absence of natural gene flow among populations of these fishes leaves the long-term genetic viability of these isolated populations in question. Additionally, several madtom species have, for unexplained reasons, been extirpated from portions of their range. Etnier and Jenkins (1980) speculated that this may "...in addition to visible habitat degradation be related to their being unable to cope with olfactory 'noise' being added to riverine ecosystems in the form of a wide variety of complex organic chemicals that may occur only in trace amounts." If madtoms are adversely impacted by increased concentrations of complex organic chemicals, an increase in the presence of these materials could be a problem for the pygmy madtom.

Etnier and Jenkins (1980) commented that many madtoms are apparently restricted to only the best remaining riverine systems. Etnier and Starnes (1991) suggested that madtoms are disproportionally represented within groups of jeopardized fishes, probably because of their specialized reproductive habits. In addition, he noted that species restricted to medium-sized rivers are disproportionally jeopardized, in comparison with other aquatic habitats in Tennessee.

The Tennessee River previously supported one of the world's richest assemblages of temperate freshwater river fishes (Starnes and Etnier 1986, Sheldon 1988), but this river is now one of the United States' most severely altered river systems. Most of the main stem of the Tennessee River and many of its tributaries are impounded. Over 2,300 river miles, or about 20 percent, of the Tennessee River and its tributaries with drainage areas of 25 square miles or greater are impounded (Tennessee Valley Authority 1971). In addition to the loss of riverine habitat within the impoundment, most impoundments also seriously alter downstream aquatic habitat.

Silt is particularly degrading to these riverine systems. Berkman and Rabeni (1987) demonstrated that the accumulation of silt in streams decreases both the faunal and habitat diversity. They also suggested that, in addition to impacting the overall community, it specifically impacts nest cavity spawners (including madtoms) by limiting the availability of clean nesting sites.

Coal mining-related siltation and associated toxic runoff have adversely impacted many stream reaches. Numerous streams have experienced fish kills from toxic chemical spills, and poor land use practices have resulted in silt covering the bottoms of many rivers. The runoff from large urban areas has degraded water and substrate quality. Because of the extent of habitat destruction, the aquatic faunal diversity in many of the Tennessee River basin's rivers has declined significantly. Many species that once existed throughout major portions of the Tennessee River now exist only as isolated remnant populations (Neves and Angermeier 1990), and extirpations and extinctions are predicted (Sheldon 1988, Etnier 1993). Because of the destruction of riverine habitat, 10 fishes and 24 mussels in the Tennessee River basin have already required Endangered Species Act protection, and numerous other aquatic species in this basin are currently considered as candidates for Federal listing.

PART II

RECOVERY

A. Recovery Objectives

The ultimate goal of this recovery plan is to restore viable populations* of the pygmy madtom (*Noturus stanauli*) to a significant portion of its historic range and remove the species from the Federal List of Endangered and Threatened Wildlife and Plants. However, based on our current knowledge of the species and its distribution, it is likely that this species will always need the protection of the Act.

Reclassification to threatened:

The species will be considered for reclassification to threatened status when the likelihood of the species' becoming extinct in the foreseeable future has been eliminated by the achievement of the following criteria:

1. Through protection and enhancement of the existing population in the Duck River, Humphreys and Hickman Counties, Tennessee; and in the Clinch River, Hancock County, Tennessee, two viable populations* exist.

2. Studies of the fish's biological and ecological requirements have been completed and the implementation of management strategies developed from these studies has been or is likely to be successful.

3. No foreseeable threats exist that would likely cause this species to become endangered.

*Viable populations: A reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes. The number of individuals needed and the amount and quality of habitat required to meet this criterion will be determined for the species as one of the recovery tasks.

Removal from Endangered Species Act protection:

Removal of the pygmy madtom from the Act's protection is not likely. This species may have historically been widespread in the Tennessee River system. However, it currently exists at only two areas in the Tennessee River system (about 600 miles apart), and the river reach between these populations is significantly impacted by impoundments and is not suitable for reintroductions. Therefore, no criteria are given at this time for delisting the species.

B. Narrative Outline

1. Preserve the present population and presently used habitat. Because only two populations exist, it is essential that these populations be protected.

1.1 Continue to utilize existing legislation and regulations (Federal Endangered Species Act, Federal and State surface mining laws, water quality regulations, stream alteration regulations, Federal Energy Regulatory Commission licensing, etc.) to protect the fish and its habitats. Prior to and during implementation of this recovery plan, the species and its habitat should be protected by the full enforcement of existing laws and regulations.

1.2 Solicit help in protecting the species and its essential habitats through the development of cooperation and partnerships with Federal and State agencies, local governments, industry and farming groups, conservation organizations, and local landowners and individuals. Section 7 consultation under the Endangered Species Act and Fish and Wildlife Coordination Act activities can assist in the protection of the species, but these programs alone cannot recover the pygmy madtom. The assistance of Federal and State agencies and conservation groups, as well as local governments, will be essential. Also, support of the local industrial and business community, as well as local individuals and landowners, will be needed to meet the goal of preserving this species and the ecosystem that this and numerous other rare species depend upon. Without a commitment from the people who live in the vicinity of the watersheds and who have an influence on habitat quality, recovery efforts will be doomed.

1.2.1 Meet with local government officials and regional and local planners to inform them of our plans to attempt recovery and request their support.

1.2.2 Meet with local business, industry, and farming interests and try to elicit their support in implementing protective actions.

1.2.3 Develop an educational program using such items as slide/tape shows, brochures, etc. Present this material to schools, business groups, civic groups, youth groups, church organizations, etc. Information/education material should outline the needs of the pygmy madtom. However, it is essential that this information material stress the dramatic decline in both habitat quality and

biodiversity within the Clinch and Duck Rivers. The public should be informed that the problem is the loss of overall environmental quality within these ecosystems, not just a problem for the pygmy madtom. The educational material should also provide information on actions local people can take to begin to improve the environmental quality within these rivers.

1.3 Determine threats to the species, conduct research necessary for the species' management and recovery, and implement management where needed.

1.3.1 Conduct life history and demographic research on the species to include such factors as reproduction, food habits, age and growth, and mortality. Very little is known concerning this species' life history requirements. In particular, information is needed on the life span, fecundity, and size of existing populations. This information is essential in order to understand the species' needs and to begin to target specific management and conservation actions.

1.3.2 Characterize the species' habitat (relevant physical, biological, and chemical components) for all life history stages. Little is known of the pygmy madtom's habitat requirements except that it has been found in moderate to large rivers on shallow shoals, where there is pea-sized gravel and where there is a moderate to strong current. Knowledge is needed as to the species' habitat requirements and ecological associations for each population in order to focus management and recovery efforts on the specific problems within the species' habitat.

1.3.3 Determine present and foreseeable threats to the species. Siltation from poor land use and road construction practices and coal mining has contributed and continues to contribute to substrate and water quality degradation. The mechanism by which the species and its habitat are impacted by these factors is not entirely understood, and the extent to which the species can withstand these impacts is not known. Other undetermined factors may also be impacting the species. Research, using surrogate species, is needed to provide insight into the potential impacts of various factors on the pygmy madtom.

1.3.4 Based on the biological data and threat analyses, investigate the need for management, including habitat improvement. Implement management, if needed, to secure viable populations. Specific components of the species' habitat, such as spawning habitat, may be lacking, and these may be limiting the species' potential expansion. Habitat improvement programs, such as repair or restoration of riparian habitat, may be needed to alleviate the impact of silt. The Service's Tennessee National Wildlife Refuge has land bordering the lower Duck River. Habitat restoration efforts here may be appropriate.

1.3.5 Develop cooperative ventures with private landowners to restore riparian habitat through programs like "Partners for Wildlife." The Nature Conservancy and the Service have begun programs to restore riparian habitat and control agricultural runoff. Where appropriate, these programs should be encouraged in order to protect and enhance pygmy madtom habitat.

1.3.6 Determine the number of individuals required to maintain a viable population. Inbreeding depression can be a major obstacle to species recovery, especially if the remaining population sizes are small and/or have gone through some type of genetic bottleneck. The actual number of individuals in a population is not necessarily a good indication of a population's genetic viability; rather, the "effective population" size is needed. The effective population size is the size of an "ideal" population in which genetic drift takes place at the same rate as in the actual population (Chambers 1983). Franklin (1980) suggested that the inbreeding coefficient should be limited to no more than 1 percent per generation, a figure which implies that the short-term, maintenance effective-population-size should be no fewer than 50 individuals (Frankel and Soulé 1981, Franklin 1980, Soulé 1980). Because the effective population size is typically only one-third to one-fourth the actual population size (being affected by sex ratio, overlapping generations, generally nonrandom distribution of offspring, and nonrandom mating) (Soulé 1980), a population of 150 to 200 individuals is needed for short-term population maintenance. Frankel and Soulé (1981) state that natural populations with effective sizes of "less that 50 to 100 are in immediate

danger and require immediate genetic management." Soulé (1980) further suggests that for long-term (indefinite) viability, an effective population of 500 individuals is necessary, translating into a population size of 1,500 to 2,000 individuals. The effective population size of the remaining pygmy madtom populations needs to be determined in order to calculate whether these populations are capable of long-term self-maintenance or whether a breeding program should be initiated (moving individuals between populations). Some of these factors can be addressed under Task 1.3.3, while others will need to be addressed as part of this task on a need-to-know basis.

2. Search for additional populations and/or habitat suitable for reintroduction efforts. The Tennessee River has been extensively surveyed. However, it is possible that some small pygmy madtom populations were missed. This is particularly relevant because of the secretive nature of the pygmy madtom and the difficulty of capturing it. Even in areas where the species is known to exist, it is often not collected. Further study may reveal additional populations; suitable habitat for transplants may also be identified during these surveys. Appropriate habitat may be available for the species in the lower Duck River, where the Service's Tennessee National Wildlife Refuge has land bordering the river.

3. Determine the feasibility of (1) reestablishing the pygmy madtom into historic habitat and (2) augmenting existing populations. Introduce the species where feasible. The extent of the pygmy madtom's historic distribution is not known, but based on the widely disjunct nature of existing populations, it is likely that the species was at one time more widespread in the main stem of the Tennessee River and possibly in the lower portions of its larger tributaries. Presently, it is known from only two populations, and the status of both of these populations is unknown. Impoundments have isolated these two populations from each other and have diminished the likelihood that pygmy madtoms could recolonize any historic habitat from which they may have been extirpated. If suitable stream reaches are available or can be made suitable, consideration could be given to reintroducing the species into appropriate habitat within the historic range of the species or into habitat that was likely to have been within the historic range. If existing populations appear to be declining and habitat is available, these populations may need to be augmented with captive-produced stock.

3.1 Develop techniques for reestablishing and augmenting populations. Sufficient wild stock of the pygmy madtom may not be available to allow for the removal of enough adults to establish additional populations or augment existing populations. Techniques for rearing the species and introducing the species into the wild should be developed to help ensure success. Also, as only two populations are known to exist and these populations could easily be lost to a toxic chemical spill, a captive pygmy madtom population should be maintained.

3.2 Reintroduce the species into its historic range and augment existing populations and evaluate success. Using the techniques developed in Task 3.1, reintroduce the pygmy madtom into any suitable habitat within its historic range. Also, as needed, augment existing populations. Any transplanted and augmented populations should be regularly monitored.

3.3 Implement the same protective measures for any introduced populations as outlined for established populations.

4. Develop and implement a program to monitor population levels and habitat conditions of presently established populations as well as newly discovered, introduced, or expanding populations. During and after recovery actions are implemented, the status of the species and its habitat must be monitored to assess any progress toward recovery. This should be conducted on a biennial schedule.

5. Annually assess the overall success of the recovery program and recommend action (changes in recovery objectives, delist, continue to protect, implement new measures, other studies, etc.). The recovery plan must be evaluated periodically to determine if it is on track and to recommend future actions. As more is learned about the species, the recovery objectives may need to be modified.

C. Literature Cited

Berkman, H. E., and C. F. Rabeni. 1987. Effects of siltation on stream fish communities. Environmental Biology of Fishes. 18(4)285-294.

Chambers, S. M. 1983. Genetic principles for managers. Pp. 44-45 In: C. S. Schonewald-Cox, S. M. Chambers, B. MacBryde, and W. Thomas (eds.). 1983. Genetics and Conservation - A reference for managing wild animal and plant populations. The Benjamin/Cummings Publ. Co., Inc., New York. 722 pp.

Dinkins, G. R. 1984. Aspects of the life history of the smoky madtom (*Noturus baileyi*) in Citico Creek. M.S. Thesis, University of Tennessee, Knoxville, TN. 50 pp.

Dinkins, G. R., and P. W. Shute. 1993. Life histories of two federally listed madtom catfish, *Noturus baileyi* (smoky madtom) and *N. flavipinnis* (yellowfin madtom). Unpublished manuscript.

Etnier, D. A. 1993. Our southern aquatic fauna--what have we lost and what are we likely to lose? Unpublished manuscript.

Etnier, D. A., and R. E. Jenkins. 1980. *Noturus stanauli*, a new madtom catfish (Ictaluridae) from the Clinch and Duck Rivers, Tennessee. Bull. Alabama Mus. Nat. Hist. 5:17-22.

Etnier, D. A., and W. C. Starnes. 1991. An analysis of Tennessee's jeopardized fish taxa. Jour. Tenn. Acad. Sci. 66:129-133.

------. In press. The Fishes of Tennessee. University of Tennessee Press, Knoxville, TN.

Frankel, O. H., and M. E. Soulé. 1981. Conservation and Evolution. Cambridge Univ. Press. England.

Franklin, R. I. 1980. Evolutionary changes in small populations. In: Conservation biology, an evolutionary-ecological perspective. Michael E. Soulé and Bruce A. Wilcox (eds.). Published by Sinauer Assoc., Inc., Sunderland, MA. Pp. 135-149.

Grady, J. M., and W. H. LeGrand. 1992. Phylogenetic relationships, modes of speciation, and historical biogeography of the madtom catfishes, genus *Noturus* Rafinesque (Siluriformes: Ictaluridae). Chapter 27, pp. 747-777, In: R. L. Mayden (ed.). Systematics,

Historical Ecology, and North American Freshwater Fishes. Stanford University Press. Stanford, CA.

Gutowski, M. J., and J. R. Stauffer, Jr. 1990. Feeding ecology of the margined madtom *Noturus insignis* (Richardson) (Teleos-tei: Ictaluridae). Abstract, 70th annual meeting ASIH (p. 95).

Mayden, R. L., and S. J. Walsh. 1984. Life history of the least madtom *Noturus hildebrandi* (Siluriformes: Ictaluridae) with comparisons to related species. Amer. Midl. Nat. 112:349-368.

Neves, R. J., and P. L. Angermeier. 1990. Habitat alteration and its effects on native fishes in the upper Tennessee River system, east-central U.S.A. J. Fish Biol. 37 (Supplement A). Pp. 45-52.

O'Bara, C. J. 1991. Final report on the status of the pygmy madtom (*Noturus stanauli*). Unpubl. Report to Tennessee Wildlife Resources Agency, Nashville, TN.

Sheldon, A. L. 1988. Conservation of stream fishes: patterns of diversity, rarity, and risk. Conservation Biology. 2:149-156.

Soulé, M. E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. In: Conservation biology, an evolutionary perspective. Michael E. Soulé and Bruce A. Wilcox (eds.). Published by Sinauer Assoc., Inc., Sunderland, MA. Ch. 8, pp. 151-169.

Starnes, W. C., and D. A. Etnier. 1980. Fishes. Pp. B1-B134 In: D. C. Eagar and R. M. Hatcher (eds.). Tennessee's Rare Wildlife Volume 1: The Vertebrates. Tennessee Heritage Program.

------. 1986. Drainage evolution and fish biogeography of the Tennessee and Cumberland Rivers drainage realm. In: The Zoogeography of North American Freshwater Fishes (C. H. Hocutt and E. O. Wiley, eds.), pp. 325-361. New York: John Wiley.

Starnes, W. C., and L. B. Starnes. 1985. Ecology and life history of the mountain madtom, *Noturus eleutherus* (Pisces: Ictaluridae). Am. Midl. Nat. 114:331-341.

Tennessee Valley Authority. 1971. Stream length in the Tennessee River Basin. Tennessee Valley Authority, Knoxville, TN. 25 pp.

U.S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; determination of the pygmy madtom (*Noturus stanauli*) to be an endangered species. *Federal Register* 58(79):25758-25763.

PART III

IMPLEMENTATION SCHEDULE

Priorities in column one of the following Implementation Schedule are assigned as follows:

> Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
>
> Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
>
> Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

FWS - U.S. Fish and Wildlife Service
TE - Endangered Species Division of the U.S. Fish and Wildlife Service
LE - Law Enforcement Division of the U.S. Fish and Wildlife Service
FA - Other Federal Agencies - Includes the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Soil Conservation Service, and Tennessee Valley Authority
RW - Refuges and Wildlife Division of the U.S. Fish and Wildlife Service
SCA - Includes the Tennessee Department of Environment and Conservation and Tennessee Wildlife Resources Agency
TNC - The Nature Conservancy

PYGMY MADTOM IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	Cost Estimates ($000's) FY2	Cost Estimates ($000's) FY3	Comments
1	1.1	Continue to utilize existing legislation and regulations to protect species and its habitat.	Continuous	R4/TE, RW, and LE	FA, SCA	5.0	5.0	5.0	
1	1.2.1, 1.2.2	Meet with local governmental officials and business interests and elicit their support for recovery.	3 years	R4/TE and RW	FA, SCA, TNC	5.0	5.0	5.0	
1	1.2.3	Develop an information and education program and present.	1 year (then continuous)	R4/TE and RW	FA, SCA, TNC	10.0	2.5	2.5	
1	3	Develop techniques, select sites, reintroduce the species back into historic habitat, and evaluate and protect any populations established.	3 years	R4/TE	FA, SCA, TNC	25.0	20.0	20.0	
1	1.3.1, 1.3.2, 1.3.3	Conduct research necessary for species management and recovery; i.e., habitat requirements, biology, and threat analyses.	3 years	R4/TE and RW	FA, SCA, TNC	40.0	40.0	40.0	
1	1.3.4	Based on biological and threat analyses, investigate the need for management and implement where needed.	3 years	R4/TE and RW	FA, SCA, TNC	5.0	5.0	5.0	
1	1.3.5	Develop cooperative ventures with private landowners to restore riparian habitat.	3 years	R4/TE and RW	FA, SCA, TNC	50.0	50.0	50.0	
2	2	Search for additional populations and suitable habitat.	1 year	R4/TE	FA, SCA, TNC	10.0	---	---	
2	4	Develop and implement a monitoring program.	Biennial	R4/TE	FA, SCA, TNC	5.0	---	5.0	

PYGMY MADTOM IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
3	1.3.6	Determine the number of individuals required to maintain a viable population.	1 year	R4/TE	FA, SCA, TNC	---	---	20.0	
3	5	Annually assess the recovery program and modify the program and plan where required.	Continuous	R4/TE	FA, SCA, TNC	0.5	0.5	0.5	

PART IV

LIST OF RECIPIENTS

The following agencies, organizations, and individuals were mailed copies of this recovery plan. This does not imply that they provided comments or endorsed the contents of this plan.

Mr. D. Elmo Lunn
Technical Secretary
Water Quality Control Board
Tennessee Department of Public Health
621 Cordell Hull Building
Nashville, Tennessee 37219

Mr. Gary Myers, Executive Director
Tennessee Wildlife Resources Agency
Ellington Agricultural Center
P.O. Box 40747
Nashville, Tennessee 37204

Mr. Jerry Lee
U.S. Soil Conservation Service
U.S. Courthouse, Room 675
801 Broadway
Nashville, Tennessee 37203

Mr. Edward G. Oakley
Division Administrator
Federal Highway Administration
249 Cumberland Bend Drive
Nashville, Tennessee 37228

Mr. Jack E. Ravan
Regional Administrator
Environmental Protection Agency
345 Courtland Street, NE.
Atlanta, Georgia 30365

Tennessee State Clearinghouse
1800 James K. Polk Building
501 Deadrick Street
Nashville, Tennessee 37219

Colonel James P. King
U.S. Army Corps of Engineers
Nashville District
P.O. Box 1070
Nashville, Tennessee 37202-1070

Dr. William H. Redmond
Regional Natural Heritage Project
Tennessee Valley Authority
Norris, Tennessee 37828

Mr. Paul Schmierbach, Manager
Environmental Quality
Tennessee Valley Authority
Room 201, Summer Place Building
Knoxville, Tennessee 37902

Program Administrator
Tennessee Department of Environment
and Conservation
401 Church Street
8th Floor, L&C Tower
Nashville, Tennessee 37243-0447

Dr. James Layzer
Tennessee Cooperative Fishery
Research Unit
Tennessee Technological University
P.O. Box 5114, Biology Department
Cookeville, Tennessee 38505

Mr. Julius T. Johnson
Director of Public Affairs
Tennessee Farm Bureau Federation
P.O. Box 313
Columbia, Tennessee 38401

Dr. David Etnier
Department of Zoology and Entomology
University of Tennessee
Knoxville, Tennessee 37916

Executive Director
American Fisheries Society
54 Grosvenor Lane
Bethesda, Maryland 20814

Dr. Melvin Warren
U.S. Forest Service
Southern Forest Experiment Station
P.O. Box 947
Oxford, Mississippi 38655

Dr. Brooks Burr
Department of Zoology
Southern Illinois University
Carbondale, Illinois 62901-6501

Mr. John R. Shute
Conservation Fisheries, Inc.
7108-A Commercial Park Drive
Knoxville, Tennessee 37918

Mr. Patrick Rake
Conservation Fisheries, Inc.
7108-A Commercial Park Drive
Knoxville, Tennessee 37918

County Executive
Humphreys County Courthouse
Waverly, Tennessee 37185

County Executive
Hancock County Courthouse
Sneedville, Tennessee 37869

Mr. John Taylor
U.S. Fish and Wildlife Service
Tennessee National Wildlife Refuge
P.O. Box 849
Paris, Tennessee 38242

Mr. Rich Owings
North Carolina Arboretum
P.O. Box 6617
Asheville, North Carolina 28816

Mr. Alan Smith
P.O. Box 887
Mars Hill, North Carolina 28754

U.S. Forest Service
Wildlife, Fisheries, and Range
1720 Peachtree Road, NW.
Atlanta, Georgia 30367

Environmental Protection Agency
Hazard Evaluation Division - EEB (TS769C)
401 M Street, SW.
Washington, DC 20460

Project Manager (7507C)
Environmental Protection Agency
Endangered Species Protection Program
Environmental Fate and Effects Division
Office of Pesticide Programs
401 M Street, SW.
Washington, DC 20460

Federal Highway Administration
Office of Environmental Policy
Environmental Analysis Division
400 Seventh Street, SW., Room 3240
Washington, DC 20590

Directorate for Biological, Behavioral,
and Social Sciences
National Science Foundation
1800 G Street, NW., Room 215
Washington, DC 20550

The Nature Conservancy
Eastern Regional Office
201 Devonshire Street, 5th Floor
Boston, Massachusetts 02110

The Nature Conservancy
2002 Richard Jones Road, Suite 304-C
Nashville, Tennessee 37215

The Nature Conservancy
1815 N. Lynn Street
Arlington, Virginia 22209

Dr. Gary B. Blank
North Carolina State University
P.O. Box 8002
Raleigh, North Carolina 27695-8002

Dr. Harriet Gillett
World Conservation Monitoring Centre
219 Huntingdon Road
Cambridge CB3 ODL
United Kingdom

Traffic U.S.A.
World Wildlife Fund
1250 24th Street, NW., Suite 500
Washington, DC 20037